ON

THE PATHOLOGY

OF

HOOPING-COUGH.

BY

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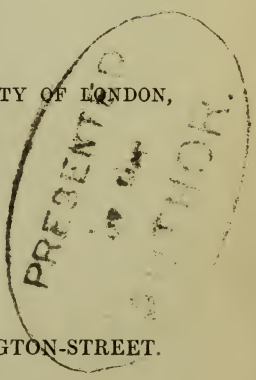

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Mr. President and Gentlemen,

In the paper which I have the honour of submitting to your notice this evening, it is my intention to enter into the consideration of certain points in the Pathology of Hooping-Cough, and to bring before you the results of the observations I have recently made on the subject. The disease in question is one of every day occurrence, and the mortality arising from it very great, as will be seen by a reference to the tables of mortality of the Registrar General. It cannot, therefore, be deemed superfluous to bring such a subject under consideration, with a view of, if possible, arriving at a more complete knowledge of the *modus operandi* of the disease in producing the fatal results so frequently observed. Dr. West, in speaking of this disease, says, there is no affection concerning which we are so much in want of definite facts. To supply in some degree this hiatus, I venture to submit to you such observations as I have been able to make. It is not my intention to enter into the question of the essential nature of the disease, or to discuss the appropriateness of placing it in this or that class in medical

nosology, the results of such a discussion being by no means evidently useful or practical, and having long ago received full consideration at far more competent hands. It will be my object to consider the disease as it is, and to endeavour to show what are the pathological conditions met with after death. Simple cases of hooping-cough are rarely fatal; the complications and consequences of the disease, then, can only be expected to be found after death; and it is to the study of these complications and consequences that pathological investigations must be necessarily directed.

An epidemic of hooping-cough which has lately occurred in the parish of St. Marylebone, and which has proved very fatal at the Infirmary and Workhouse of that parish, has afforded me an opportunity of collecting at these institutions the facts and observations which will now be brought before you. To Mr. Filliter and Mr. Mushet, the resident medical officers, I am indebted for the facilities they have afforded me for carrying on my inquiries.

The affections of the lungs and air-passages which supervene in the course of hooping-cough are generally the cause of death; and in studying the pathology of this affection, very considerable attention must be paid to them. The bronchitis of children offers, it would appear, certain characteristics as distinguished from the bronchitis of the adult; and it is also eminently probable that the bronchitis which accompanies hooping-cough differs again in certain points from ordinary infantile bronchitis, both in its nature, and in the secondary lesions of the lung thereby produced. It will be seen further on, that the occurrence of collapse of the lung in fatal cases of hooping-cough is very frequent. As I shall have to speak fre-

quently of collapse of the lung, an inquiry into the state of our knowledge respecting this condition, and its connection with infantile bronchitis, will consequently prove of service in rendering the path more clear, and the results hereafter to be mentioned more intelligible. I will therefore say a few words on this subject before relating the observations which form the basis of this paper.

It was formerly the custom to look on all cases in which the lungs were found after death solidified, or at least apparently so, as cases of pneumonia; and the differences which presented themselves between this condition and the pneumonia of the adult were explained, by supposing that in children a peculiar form of pneumonia occurred. To this condition the name lobular pneumonia was given. In 1830, Dr. Alderson published a paper in the "Medico-Chirurgical Transactions," in which he describes, as a condition peculiar to hooping-cough, a carnefied state of the lung. This carnification he describes as differing from ordinary hepatization. The portions affected were exactly defined by interlobular septa, of a dull red colour, sinking instantly in water, undergoing no change by washing; the lung substance not enlarged as in pneumonia, but contracted, and presenting a combination of looseness and density such as is felt in the pancreas. The pleura was unaffected with inflammation. Dr. Alderson points out a very important distinction, viz., that between this carnification and ordinary hepatization; and to him is due the full credit of its recognition.

The carnification of Dr. Alderson is identical with that condition of the lungs of new-born children, which Jörg first directed attention to in the year 1832, and to which, in 1835, he gave the name of atelectasis, a condition now well known and understood. Amongst the writers on affections

of the lungs in children during the next four years may be mentioned the names of Rufz, Rilliet, and Barthez, Rees and Seifert. Rufz pointed out a state of the lungs which he called carnification, and which he properly distinguished from hepatization. Seifert, in 1837, alluded to a peculiar form of pneumonia, occurring in infantile bronchitis. Rilliet and Barthez, in their essay on pneumonia published in 1838, describe a carnification which resembled that produced by compression in cases of pleuritic effusion, but which was not attended by effusion. None of these latter writers, however, seem to have perceived the relation of this peculiar carnification to the atelectasis of Jörg, nor do they seem to have contemplated the possibility of its arising from any other cause than inflammation. In 1844, Legendre and Bailly published their valuable researches on diseases of the lungs in children. They first applied to the study of these diseases a means of investigation as simple as it was in its results important, and which has, as Dr. West truly remarks, advanced the progress of knowledge in this department of pathology more than the writings of the ten previous years put together. The portions of lung affected with the so-called lobular pneumonia were found by them to be inflatable, the effect of the inflation being to restore to the portions affected their normal appearance and qualities. For the name "lobular pneumonia" they substituted the term "*état fœtal.*" They pointed out the difference which existed between the effects of inflation on the portions which exhibited the fatal conditions, and on those affected with true pneumonia, the inflation producing no effect on the latter, while it restored the former to their normal appearance and qualities. The anatomical character of this "fœtal condition" they described as follows:—The

portions of lung affected were depressed below the surface of the adjacent healthy lung, non-crepitant, firm, compact, sinking in water, section showing cellular interspaces, the colour of a red violet, sometimes darker, consistence variable, sometimes friable, the section smooth and not granular. To these characters was added the important one of the complete inflatability of the affected portions. Two varieties of this fœtal condition are described—the one simple, the other congested, the names sufficiently indicating the distinctions between them.

Since the publication of these researches, the views entertained by Legendre and Bailly have received the confirmation of most subsequent writers on the subject. Rilliet and Barthez, the authors of the well known text-book on "Diseases of Children," fully recognize the truth and importance of their observations. Bouchut denies, however, the correctness of the statement, that lung substance, in the state of hepatization, is not inflatable. Fuchs, in a work on the bronchitis of children, published in 1849, describes the same condition of the lung as that described by Legendre and Bailly, giving it the name of *apneumatosis*, in order to distinguish it from *atelectasis*, the first being an acquired, the second a congenital condition. Fuchs very distinctly connects this state of the lung with catarrhal inflammation of the bronchi.

Dr. Gairdner's valuable papers on "The Pathological State of the Lung connected with Bronchitis and Bronchial Obstruction," contained in the Edinburgh Monthly Journal for 1850—51, I must next refer to. Dr. Gairdner has fully confirmed the views of Legendre and Bailly, both as to the existence of the "fœtal condition" of the lung, called by him "pulmonary collapse," and as to its pathological signification. His observations were made

chiefly on the collapse occurring in the lungs of adults. The same appearances are, according to him, presented by the lungs of adults as are met with in those of children who have succumbed to bronchitis. The ingenious explanation given by him of the way in which this air-less state of the lung is produced, I shall have occasion to refer to in the sequel.

Friedleben, who has written on the same subject, maintains that this collapse of the lung is always a congenital condition, and that it is not acquired; an opinion, however, which other authorities, and amongst them MM. Rilliet and Barthez do not subscribe to. The results obtained by a perusal of the works of these and other authors, may be embodied in the following propositions:—

I. That portions of the lungs in young children are often found in a peculiar condition, designated variously up to the present time as *disseminated lobular pneumonia, carnification, pulmonary collapse, fœtal condition, atelectasis, apneumatosis, marginal pneumonia, etc., etc.*

II. That this condition of the lung (excluding the congenital form to which it would be more proper to confine the term atelectasis), co-exists invariably with a catarrhal inflammatory state of the bronchial mucous membrane.

III. That it is a condition essentially different from that produced by pneumonia, properly so called, the characteristic anatomical distinctions of the two being easily recognized by a due attention to the peculiarities already alluded to.

My apology for troubling you with these historical data must be, that although well established they are not sufficiently known, and consequently the deductions arising therefrom are not widely and practically acted on.

The true pathological signification of the condition, collapse of the lung, is certainly not so generally understood as it should be; and yet nothing can be more easy than the ready appreciation of it when its characters are once pointed out. Lobular pneumonia is a term constantly used in speaking of the pathological states of the lungs in children. The term must be in many cases given up and abandoned, for, as MM. Legendre and Bailly have shown, true lobular pneumonia is of comparatively rare occurrence as a pathological condition in the lungs of children, whereas collapse of the lung is, on the other hand, very frequent. The lobular pneumonia of many former writers must be taken to mean pulmonary collapse. Hence it is very necessary that this fact should be widely known, and that the error of mistaking collapse of the lung for lobular pneumonia should be no longer committed.

The facts I am about to submit to you go to prove, that the catarrhal inflammation of the bronchial tubes which occurs in hooping-cough is, in fatal cases, attended almost universally with collapse of the lungs. It will then be obvious that an attempt to direct attention to the frequency and importance of this co-existence will not be misplaced, inasmuch as the fact will have considerable influence on the question of the appropriateness of the one or the other plan of treatment, in cases where such a co-existence is to be suspected.

The observations which form the basis of this communication, and the results of which will now be given, have most of them been made at the St. Marylebone Infirmary and Workhouse, where, during this last spring, hooping-cough has been the cause of a considerable mortality. Most of them have been made on fatal cases which have occurred at one or other of these Institutions; but some of the

cases came under my notice elsewhere. The observations are nineteen in number.* The ages of the children who were the subject of them varied from four years to one month, the average being eighteen months. In all, the state of the lungs was carefully noted. The chief lesion found after death was collapse of the lung substance. The following is a statement of the degree to which this pathological condition manifested itself in the different lobes of the two lungs.

In the *right lung*, portions of the upper lobe were found collapsed in six cases, and in four more to a less degree.

The middle lobe was collapsed, wholly or in part, in sixteen cases.

The lower lobe was more or less affected with collapse in eighteen cases.

In the *left lung*, the upper lobe presented the same lesion in fifteen cases, the whole of the anterior tongue-like prolongation being in most of the cases affected.

The lower lobe was collapsed more or less in eighteen cases.

In seven of the cases, the portions collapsed were also congested—in some to a high degree.

The test of MM. Bailly and Legendre, viz., the inflatability of the portions of the lungs thus affected, was used in almost all the cases; and on that and other grounds it was determined, that the particular part of the lung in question was collapsed and not hepatized.

It will be at once perceived, that the occurrence of collapse was almost universal; all the cases, with the exception of one, in which there was extensive tuberculization of the lungs, presenting a greater or less amount of lung substance affected in this manner.

* See Table of Cases.

The collapsed portions were found to have the following general characteristics. They were abruptly separated from the adjoining healthy lobules, depressed below the general surface of the lung, less bulky than the unaffected portions. The colour varied from a reddish violet to a deep purple; the firmness was variable, in most cases, however, having a great resemblance to that of a piece of flesh, non-crepitant, sinking immediately in water, lobular cellular interspaces well marked. No air-cells visible in the surface, or on section, even with the aid of a lens. Section of collapsed portions showed a uniform smooth surface, slightly friable in some cases, and emitting on squeezing a small quantity of non-aërated puriform fluid. The lung substance did not break down under pressure, as is seen in hepatization. When a blow-pipe was introduced into the bronchus leading to the affected portions, and inflation performed, the aspect of the collapsed portions underwent a striking change. They immediately assumed the appearance of the adjacent healthy lobules, and were in no wise to be distinguished from them—becoming enlarged, and the air-cells on the surface easily distinguishable by the aid of a lens. The colour was changed from a dark violet to a light pinkish hue, such as is habitually seen in the healthy lungs of children. The lung substance was found then to float readily on water, and to have become crepitant. When these inflated portions were left to themselves for a short time, they became to a certain degree collapsed; the lung contracting and expelling a portion of the air artificially introduced. The inflation was performed with ease in most of the cases; in some, however, the force necessary to be used was more considerable, and some portions were not inflated at all by the additional force used. The portions

which occasionally resisted full inflation were the posterior surfaces of the lower lobes.

The depth to which the lung substance was implicated was variable. In all cases the collapse exhibited a preference for the portions of the lobes most distant from the root of the lung—thus the margins of the lobes were found chiefly affected. A great part of a whole lobe was, in many cases, collapsed deeply as well as superficially; the upper lobes, however, were never found very deeply affected.

The anterior tongue like prolongations of the two upper lobes were, in nearly all the cases, collapsed, and were thin, pliable, and *lobulated*, to the feel, if I may be allowed the use of such a term. The external surface of the upper lobes often presented little digital pits or depressions, the depressed surfaces being of a colour approximating to violet, and constituted by lobules in a semi-collapsed state. Inflation quickly gave the lobe a uniform, smooth surface.

Such was the general appearance and character presented by the collapsed portions. In many of the cases these portions were themselves the seat of other alterations, to which I shall now allude. The collapsed portions, in several instances, were spotted on the external surface, which was due to the fact that certain air-cells, either singly or in groups, were distended with a mucopuriform fluid. They were chiefly seen on the external surface, but a section also showed them, though less distinctly. The patches thus constituted were of a variable size, but mostly as large as a millet seed, very slightly elevated above the surface, of an opaline grey or yellowish colour. On pricking them with the point of a lancet, a small quantity of puriform fluid

exuded, and the little eminence disappeared. They were very different in appearance and general characters from tubercular deposits, for which, however, they might, at first sight, have been taken. They were identical with what has been described by Legendre and Bailly as the first and second stages of their catarrhal pneumonia. Section of the lobules affected in this manner exhibited similar spots or patches. A further stage of this process was exhibited in some of the cases, where cavities of a larger size were found occupying the terminal extremities of the bronchial tubes. They were, for the most part, scattered, and not very numerous, always situated in portions of the lung which were collapsed. In one case (No. XII.) a very advanced stage of this condition existed. A large portion of the lobes of both lungs were, in this instance, occupied by cavities, some of which were large enough to admit a small marble, and communicated freely with the bronchia. The external surface of the lobes thus affected, presented large elevations of a rounded character, very much resembling small bladders. These cavities contained pus and air mixed together. When dried, the lung presents a honeycomb appearance, as is well seen in the preparation exhibited. Several adjacent air-vesicles affected with catarrhal inflammation have evidently coalesced, the walls between them having been destroyed. In the recent state, the cavities were lined by a reddish membrane. A portion of the middle lobe was in this case unaffected, and the contrast between the two portions is very remarkable, the line of demarcation between the healthy and diseased portions being quite abrupt. There was no induration of the lung substance surrounding these cavities, and nothing besides the thin wall of the air vesicles intervening between them and the pleura.

The case from which this specimen was taken was one when the disease had lasted some time. The cavities in question resembled very much the vesicles of emphysema, from which, however, they differed in containing pus as well as air, and in other particulars. Barrier first pointed out the true nature of these cavities, which are called by the French observers "vacuoles," by others "bronchial abscesses." It is very rare that these are seen so large and well marked. Dr. Alderson, in the paper I have before alluded to, mentions the occasional existence of bronchial dilatations occupying the extremities of the bronchia in some of the cases of hooping-cough which he examined. These enlargements were doubtless identical with the vacuoles I have just described. In some other cases which came under my observation, these vacuoles were found, but their size was not generally greater than that of a pin's head. True dilatation of the bronchial tubes was not met with in any of the nineteen cases; the dilatation was always terminal, and occupied the air-cells rather than the bronchial tubes.

The *mucous membrane* of the bronchial tubes was in some cases slightly injected. In almost all, the tubes were filled more or less by a muco-purulent fluid, rather tenacious in consistence, and in the tubes leading to collapsed portions non-aërated.

The air cells in the lobules immediately adjoining the collapsed portions were enlarged, although this enlargement was never found to be great in degree. It was, however, quite obvious with the aid of a lens. The space created by the collapse of certain portions, appeared to be filled up by a corresponding increase in the bulk of the parts adjoining; thus, in some cases, where the tongue of the upper left lobe was collapsed, it was tilted down-

wards and backwards, while its position was occupied by an emphysematous portion of the remainder of the lobe.

True inflammation of the parenchyma of the lung was only seen in four cases. In one, a large portion of the upper right lobe was affected, and tubercle found in the bronchial glands. Hepatization to a slight extent, and confined to one or two lobules scattered here and there in the lung, was met with in one or two other cases. The bronchial glands were, in all the cases where attention was directed to them enlarged, congested, friable. In three of the cases they were infiltrated with yellow tubercle.

The state of the *pleura* was also observed. In five cases only were there any adhesions found, and in two of these the lungs were tuberculous. In one of these tuberculous cases, both pleural cavities contained a tolerable quantity of effused fluid, but no fluid was found in the other cases. No appreciable change was detected in the vagi nerves, although they were examined in most of the cases.

The *larynx* and *trachea* presented nothing remarkable; they contained generally a certain quantity of puriform fluid. The mucous membrane was never markedly injected.

In all these cases, then, the bronchial tubes were the seat of a catarrhal inflammation, affecting chiefly the smaller tubes, and in many cases the air-cells themselves. An inflammation occupying the smaller air-tubes has been called variously capillary bronchitis, broncho-pneumonia, catarrhal pneumonia, vesicular bronchitis. The two latter terms seem the most appropriate, particularly as applied to the affection of the lungs which occurs

in hooping cough. There would appear to be an intimate connection between this catarrhal pneumonia and collapse of the lung; the one seems to have an important influence in causing the production of the other. What has been improperly termed lobular pneumonia is, in reality, collapse of the lung, brought about by the catarrhal inflammation of the minute bronchia. It is not pneumonia at all in the true sense of the word. In the hepatization of pneumonia, the lung substance is enlarged, hard, firm, very friable, breaking down into a purulent-looking detritus on pressure; the cut surface is granular, and inflation produces no effect in restoring to the parts affected the natural appearance and physical character. The hepatized portions are non-crepitant, and sink in water, agreeing in these characters with the collapsed portions.

Too much importance can scarcely be attached to this distinction; and there can be no doubt that many cases in which collapse of the lung only existed, have been treated as if pneumonia were present, and therefore inappropriately. An antiphlogistic mode of treatment might suit the one kind of case, but it would tend to hasten a fatal result in the other.

An interesting question has next to be considered. What is the relation which bronchial inflammation bears to collapse of the lung? what, in fact, is the mechanism of the production of this latter condition? It is very obvious that the effects produced on the system at large by the non-aëration of a great portion of the lungs must have a very important influence in impeding the due oxygenation of the blood, and consequently in lowering the standard of vitality. We are therefore warranted in devoting some little attention to the consideration of this

process, and in studying the conditions under which it ordinarily takes place. The question has received some attention from recent writers on bronchitis, although they have not more than casually alluded to the existence of collapse in fatal cases of hooping-cough. Dr. West states, that a feeble condition of the respiratory powers co-existing with a large secretion of mucus into the bronchi, is sufficient to produce collapse of a large portion of the lungs. Dr. Gairdner, in the papers I have before alluded to, gives what I consider to be a very lucid and satisfactory explanation of the mechanism by which collapse of the lung is produced; and his remarks on this point I shall now quote. Dr. Gairdner first points out the inaccuracy of Laennec's statement, to the effect that the inspiratory force is greater than the expiratory—the fact being that the expirative force is actually one-third greater than the other. The collapse of the lung is produced, according to Dr. Gairdner, by bronchial obstruction; the way in which this acts being explained as follows. Supposing a particular bronchus to be occupied by tenacious mucus, the air will more readily pass by this mucus *from* the air-cells than *to* the air-cells, and for these reasons: the expiratory force, in the first place, is stronger than the inspiratory; and, secondly, as the bronchial tubes progressively diminish in calibre as they approach the air-cells, the obstructive material will more easily pass towards the root of the lung than in the opposite direction. It will thus act as a kind of ball-valve, allowing the tube to be pervious in one direction only, and preventing the air from passing into the air-cells. The expiratory act opens the tube by moving it a little; the inspiratory act closes it. If the efforts of coughing are insufficient to remove the obstructing mucus, the result

of a continuance of this process will be in the end to remove all the air contained in the lobules to which the obstructed bronchus leads. The experiments of Mendelssohn and Traube are confirmatory of the views entertained by Dr. Gairdner. These observers placed small shot and other small articles in the bronchial tubes of certain animals, and on killing the animals after some time had elapsed, they found that the portions of lung to which the obstructed bronchi led were collapsed and destitute of air.

It does not appear necessary, judging from the cases which I have myself observed, that the mucus which has this important influence in inducing collapse of the lung (if the theory of Dr. Gairdner be true), should be of a very tenacious character, in order that it may produce such an amount of obstruction as shall result in collapse of the lung.

Dr. Gairdner ascribes an important part in the causation of the collapse to a feeble condition of the general powers; the action of the respiratory muscles being thus weakened, and the act of inspiration inefficiently performed. He quotes the observations of Dr. Rees, who pointed out the influence exercised by the mechanical conformation of the thorax in young children in preventing a due perfection of the respiratory process. The peculiarity of this conformation is this—that the walls of the thorax are less firm and resistant than in adults, and in consequence of this the act of inspiration produces a falling in of certain portions of the walls instead of the opposite result, expansion. My own personal observations have enabled me to confirm this valuable remark of Dr. Rees. These and other arguments used by Dr. Gairdner, seem almost conclusive as to the truth of the theory by which he seeks to explain the production of collapse of the lung.

It may be expected that children subjected to the bad influences of impure air and defective hygiene will be more liable to become affected with collapse of the lungs than children who have not these disadvantages to contend with. The vital functions are carried on with less energy under the former circumstances; the nervous centres, no longer supplied with a healthy nutrient fluid, do not maintain the accustomed perfect action of the processes which subserve to the preservation of life. The respiratory process, one of the most important of these, languishes, and if under these circumstances hooping-cough attacks the patient, and the air-tubes become filled with the catarrhal secretion, which is the invariable concomitant of this disease, there is not sufficient power left to effect either the due elimination of this obstructive material from the bronchi or the due expansion of the pulmonary lobules. If the child be very young, the conditions will be still more favourable for the production of collapse of the lung. The disease proves more quickly fatal in very young children; and, in the cases which I have observed, collapse of the lung was almost the only lesion found after death, up to about two years of age. In other cases, with the collapse were found further changes seated in the collapsed portions themselves—bronchial abscesses or vacuoles, etc., life having been prolonged for a sufficient time to allow of additional disorganization of the lung substance.

Some of the causes already mentioned are no doubt sufficient to cause collapse of the lungs in cases other than those of hooping-cough. Beyond the causes which have been alluded to, there is, in my opinion, another circumstance tending particularly to induce collapse of the lung in hooping-cough. The cough, which, from its peculiar

character has given the name to the disease, consists of a series of short forcible expirations followed by a long-drawn inspiration; then again follows another series of expirations, immediately succeeded by an inspiratory act; and so on for a variable number of times, the whole series of successive expirations and inspirations constituting what is called the "fit"—the fit returning at intervals during the day, and with greater frequency at night. Now the effect of the numerous successive expirations must be to empty the lungs pretty completely of air, so far at least as the lungs can be emptied, this process having of course certain limits. I have counted as many as twenty-five expiratory efforts occurring consecutively before any inspiration took place. The inspiratory act which follows is, it is to be presumed, inefficient and incomplete; for the hoop which characterizes it must be held to indicate the existence of some impediment to the entry of air at the glottis itself. This again is a circumstance tending in the same direction, viz., to prevent air entering the lungs, and furthering the production of collapse of the lobules.

It may readily be imagined, that after this great expulsion of air from the air-cells, if the powers of the child be weak, some portions of the lung will not again receive their full complement of air, and, *à fortiori*, if portions of mucus not expelled are left to block up the entrance to the air-cells of these portions. I am not prepared to say in what proportion of cases of simple bronchitis in children, not connected with hooping-cough, collapse of the lung occurs, but I cannot help thinking that the universality with which this lesion was found to exist in the cases of hooping-cough which I have examined, points to the conclusion that hooping-cough has some especial influence in

producing the lesion in question; and if so, the explanation I have offered of the manner in which this influence is exercised seems a rational one.

As will be seen from what I have before stated, the fact of collapse of the lung occurring in cases of hooping-cough is not a new one; but the results of the *post mortem* examinations which I have now brought before you will, I trust, give a degree of positiveness and exactness to the opinion as to the existence of a connection between the disease and the lesion, in which it was before wanting. It is undoubted that collapse of the lungs is found in other catarrhal inflammations of the bronchial tubes; but it may be questioned whether it is, under any other combination of circumstances, so common as in the catarrhal inflammation which attends hooping-cough.

The due recognition of the connection between a catarrhal inflammation of the air-tubes, and collapse of the lung must have a very considerable influence on the question of the treatment to be adopted in such cases. It should be remembered, that the younger the child, the greater is the probability that the lungs will become affected with collapse, consequent on the affection of the air-passages.

Another question of great interest is the secondary effect of collapse of one portion of the lung on other portions not in the same condition. The observations I have made on this subject enable me to state that a secondary effect is produced, and what that effect is I will now go on to specify. As I have before remarked, the size of the air-cells at different situations on the surface of the lungs was examined with the aid of a lens, the result of such examination being to establish the fact that in the lobules immediately adjoining those which

were collapsed, the air-cells were decidedly enlarged. The extent of surface which presented this enlargement of the air-cells bore a certain and constant ratio to the amount of lung which was collapsed; thus, when the collapse was slight in amount, the air-cells in the adjoining lobules were little altered, and *vice versâ*. These facts are strongly confirmatory of the opinion of Dr. Gairdner, as to the production of emphysema generally by collapse of the lung. The vacuum which would be formed in the cavity of the thorax by collapse of a portion of its contents, must necessarily be occupied by some solid or gaseous material, and it is obviously the most probable occurrence, that in order that this vacant space may be filled up, the lung substance near it will be further expanded, the air-cells becoming thus dilated, and emphysema produced. According to this theory, emphysema is a *complementary* lesion. Dr. Gairdner is of opinion that emphysema is always produced in this way. This may or may not be the case; my own observations are not sufficiently numerous to enable me to give an opinion. Thus much may, however, be with truth stated, that in those of the foregoing cases in which emphysema was observed, this theory seemed the only adequate explanation of the appearances which presented themselves.

If the subject be attentively considered, it will, I think, be seen that there is a reason for the persistence of the emphysematous condition, supposing it to have been once produced. If the portion of lung affected with collapse remain in this condition for any length of time, and the adjoining lobules are at the same time emphysematous, the existence of this emphysema will tend to prevent the collapsed portions from resuming their natural condition, and the evil will be perpetuated. The thorax is occupied

by the necessary bulk of lung substance, and the inspiratory efforts will have no effect in dilating the collapsed lobules, unless they are more forcible than usual, and perhaps not even then; for the powers of the system are generally so reduced and debilitated by the influence of the disease, that none of the functions are carried on with their usual activity and force. The emphysematous condition may thus continue, rendering the patient, during the remainder of life, affected with this strictural lesion, and its well known concomitant, chronic bronchitis. I have had very recently under my care a little boy, who, since he was the subject of hooping-cough some years ago, has been liable to severe and frequent asthmatic attacks. There is in this case emphysema of the lungs, and this condition seems to be the result of some such a process as I have endeavoured to describe.

The *symptoms* which present themselves during life, and which are observed in cases where collapse of the lungs is found after death, I will now briefly allude to; my remarks applying, of course, to cases of hooping-cough only. The respirations are very much quickened, being often as many as seventy-five or eighty in the minute. The character of the respiration is peculiar. The patient seems to labour very little compared with what would be expected from the frequency of the respirations, and with what is observed in other acute affections of the lungs; but the inspirations seem to be cut off and shortened abruptly, before much expansion of the thorax has been produced—the respiration may be characterized as shallow and imperfect. The examination of the chest shows absence of the usual resonance on percussion in certain regions, varying in degree in all cases. The regions at which this dulness may be expected to be found, are the infra-

mammary in front, and the lower portion of the thorax behind, corresponding, in fact, to the surface of those parts of the lungs which after death are found most frequently affected with collapse. This dulness often appears suddenly; the chest may be perfectly resonant at a particular spot one day, and an observation made the day following may afford evidence of the existence of considerable dulness on percussion at the same place. Coincidently with this change, the general symptoms will become worse, the respiration more frequent. It is at all times more difficult in children than in adults, to establish satisfactorily the limits of a certain dulness, for the dull sound heard on percussion may be due, not as would appear at first sight, to solidification immediately beneath the finger, but situated more or less deeply in the thorax, and transmitted to the surface. The effect of the existence of enlarged bronchial glands in producing this result is well known to those much accustomed to the physical examination of the lungs in children. In the case of collapse of the lung, however, it will be more easy for the observer to satisfy himself as to the nature of the dulness arising therefrom, inasmuch as it will be found to exist over parts of the lung farthest removed from the bronchial glands; viz., the periphery of the lobes. This dulness may only exist for a time, and then pass away, the lung returning to its natural condition—a change, however, which I have unfortunately not often observed.

The dulness is one sign; another is the more or less complete absence of the usual vesicular murmur, and a substitution for it of a finish subcrepitant rhonchus; this rhonchus also varying extensively in degree and character as the tubes in the immediate neighbourhood happen to be filled with mucus or free from it. And this last is an

important circumstance, influencing as it does very considerably the nature and character of the sounds heard during auscultation. A limited portion of the surface of a lobe may present very different physical conditions; one part may be emphysematous, another collapsed—and this latter portion may perhaps contain the little terminal cavities, denominated bronchial abscesses. It is not to be wondered at, then, that so much variety is observed in the nature of the sounds heard through the stethoscope; these different conditions must give rise to different sounds, which the ear is incapable of distinguishing, because they are all heard together. A fact worthy of great attention is, the suddenness with which the dulness arising from collapse of the lung makes its appearance; and I believe this to be of great service in the diagnosis of the occurrence of this particular condition, collapse of the lung substance. In one or two cases the skin was very hot, and the febrile disturbance considerable at the time of the supervention of the other symptoms which indicated the sudden production of collapse; but in most of the other cases, it was either not observed, or it did not exist, and afterwards the skin became cool, and without any febrile action being present. The pulse, though very quick, is very feeble. It must be remarked, however, that the age of the patient will have some influence in these particulars. If the child be very young, it will become sooner affected with collapse of the lung, the powers being less able to resist the producing causes; and under these circumstances less febrile reaction will be set up than when the child is older, and the disease continues longer. In the latter case, the powers of nature have greater effect in resisting disease, and it may be expected that an indication of this will be presented in the greater degree of pyrexia observed,

together with the other symptoms which usually accompany the inflammatory affections of the lung substance, whether acute or chronic.

The question of the treatment of cases of hooping-cough where there is reason to believe that portions of the lungs have become collapsed, is one of great interest, and my limits will not allow of my entering upon it in this place. It is to be hoped that the further progress of pathological and other knowledge will, in the end, remove hooping-cough from amongst the number of those diseases treated almost solely on empirical principles, and that, in the end, such a knowledge of the disease in question will be arrived at as will enable the physician to treat this disease on scientific principles. If the facts which I have brought before you tend to throw some light upon a subject which has hitherto remained in a certain amount of obscurity, the end which I have had in view in detailing the results which have presented themselves to me will have been attained. The subject is one calling for much investigation, and it is only by patient inquiry after facts, in this as in other similar diseases, that we can arrive at a true indicative for the successful treatment of this affection.

17, Radnor-place, Hyde Park,
September, 1855.

APPENDIX.

THE *post-mortem appearances* in the cases alluded to in the course of the paper, will now be given in a short tabular form. The chief design of the table is to show the comparative frequency with which the different portions of the lungs were found affected with collapse; and from it the deductions previously mentioned relative to this comparative frequency have been drawn. A very short account of the duration of the disease, and of the prominent features of each individual case, is also given.

The "Nursery" of the St. Marylebone Workhouse contains infants under the age of two years. On arriving at this age, the children are sent to the "Infant school," situated in another part of the building. From the Infant School the children are conveyed, when ill, to one of the wards specially appropriated to children in the Infirmary; and when practicable, they are under like circumstances removed from the Nursery to the Infirmary. These observations are necessary, as without them the signification of the words "Infirmary" and "Workhouse" about to be used, would not be properly understood.

TABLE OF CASES.

No. of Case.	Name, Age, Account of Illness, etc.	Right Lung.			Left Lung.		Bronchi.	Bronchial Glands.	Other Organs.
		Upper Lobe.	Middle Lobe.	Lower Lobe.	Upper Lobe.	Lower Lobe.			
I.	Charles T., æt. 2 years; admitted into Infirmary, Feb. 14th; had had hooping-cough one week; on Feb. 24th, sudden dyspnœa and œdema of lower extremities was observed; died Feb. 26th, rather suddenly.	Lower and anterior borders collapsed; air-cells adjacent enlarged.	A small portion collapsed.	Whole of lower margin collapsed.	Whole of posterior surface collapsed.	A small portion of the margin below collapsed.	Do not contain much mucus.	Not examined.	Liver congested; urine in the bladder contained a little albumen; kidneys congested; brain soft; slight amount of subarachnoid effusion, none in ventricles: pleuræ slightly adherent.
II.	Thomas S., æt. 3 years; admitted into Infirmary in January for cough; hooping-cough noticed Feb. 12th; Feb. 19th, symptoms much worse; died Feb. 26th; last day or two hæmorrhage from bowels, and last day convulsions of one side of the body.	Anterior portion collapsed; minute yellow spots on surface of collapsed portion constituted by air-cells filled with secretion.	Slightly collapsed.	Lower portion collapsed, and containing numerous small cavities situated at the termination of bronchi; the cavities contain yellow purulent matter.	Anterior border collapsed; section of this portion presents small pale nodules.	Large portion collapsed; terminal dilatations of bronchi.	Contain a quantity of secretion.	Much enlarged and congested.	Some of mesenteric glands contain cheesy tubercle; arachnoid contains one ounce serosity, ventricles of brain, each one drachm; a small calculus, the size of a pea, in each pelvis of the kidneys.
III.	Arthur G., æt. 2 years; admitted into Infirmary, Feb. 1st, with slight cough; on Feb. 27th, a hoop was first heard; March 1st, convulsions and dyspnœa set in; died March 5th.	For the most part healthy.	A very small portion collapsed.	Whole of lower margin and a good portion of posterior surface collapsed. The collapse extends deeply, involving half of the lobe; collapsed parts are congested; one small portion could not be inflated.	Considerable portion collapsed, chiefly lower portion.	Nearly whole of lobe collapsed, and very considerably congested.	Contain but little mucus.	Not examined.	Head very large, having same external measurements as the head of a youth aged 18; slight subarachnoid effusion; one ounce of fluid in arachnoid; grey substance has peculiar gelatinous look; thymus gland very large.

No. of Case.	Name, Age, Account of Illness, etc.	Right Lung.			Left Lung.		Bronchi.	Bronchial Glands.	Other Organs.
		Upper Lobe.	Middle Lobe.	Lower Lobe.	Upper Lobe.	Lower Lobe.			
IV.	John B., æt. 2, died March 5th; had been the subject of hooping-cough in common with several infants in the nursery of the Workhouse for a week or two.	Apex has a puffy appearance due to enlargement of air-cells; lobe contains one portion the size of a pea, friable and injected.	Anterior portion wholly collapsed.	Lower border collapsed.	Apex similar in appearance to that of right lung; anterior border and tongue collapsed.	Lower border and under surface extensively collapsed, involving greater portion of lobe.	Contain much muco-pus.	Enlarged, congested.	
V.	Margaret H., æt. 9 months, spoon-fed from birth; has been brought up in nursery of Workhouse; died March 10th, after having had hooping-cough for one month.	A portion of the anterior border, the size of a pigeon's egg, hard and condensed, hepatized; section of a dull yellow colour; a portion of this hard mass is brightly injected, and a third portion has all the characters of collapsed lung. The latter portion inflatable, the former not so.	Condition not noted.	Extensive collapse of lower border and under surface, involving quite half of the lobe.	A small nodule of pulmonary apoplexy close to pleural surface; otherwise healthy.	Lower border and under surface collapsed. As in the case of other collapsed portions, these emitted non-aërated muco-pus on squeezing.	Contain but little mucus.	Congested.	Mesenteric glands enlarged and congested.

TABLE OF CASES—*continued.*

No. of Case.	Name, Age, Account of Illness, etc.	Right Lung.			Left Lung.		Bronchi.	Bronchial Glands.	Other Organs.
		Upper Lobe.	Middle Lobe.	Lower Lobe.	Upper Lobe.	Lower Lobe.			
VI.	George H., æt. 6 months: had apparently recovered from an attack of hooping-cough, was discharged from nursery of Workhouse; two days after re-admitted, being much worse; convulsions came on twelve hours afterwards, and the child died next day, March 14th.	Upper two-thirds healthy, lower third collapsed; surface of collapsed portions presents little greyish, slightly elevated spots, shown to be small collections of pus at the termination of the bronchia on being pricked. These portions have a *lobulated* feel, so to speak.	Upper part healthy; lower, collapsed and small collections of purulent mucus seen on the surface of latter portions.	Considerable sub-pleural ecchymosis, as if blood had been dropped on the surface; patches of these vary in size from a pin's head to that of a shilling; lower border collapsed and congested.	Anterior tongue collapsed; collapsed part has appearances described in right upper lobe.	Considerable sub-pleural ecchymosis; lower portion collapsed.	Contain much muco-pus.	Very large; deeply congested.	Liver pale, small; right lung adherent everywhere to ribs; left partially so.
VII.	George W., æt. 6 months; died March 15th, in nursery of Workhouse, having had hooping-cough a fortnight.	Air-cells large, giving lobe a puffy appearance.	Anterior third collapsed, and of a lighter violet colour than usual; small patches on surface containing pus.	Lower margin collapsed, as also greater part of posterior and under surface.	Air-cells large; lobe puffy, with depressed portions here and there; languette collapsed; air-cells on surface contain pus at certain situations.	One-fifth of lobe collapsed chiefly at lower margin and on posterior surface; extending to depth of half an inch.	Contain considerable quantity of muco-pus.	Large, congested, friable.	Liver congested; mesenteric glands large; six invaginations of small intestine, apparently post-mortem as to date of production.
VIII.	Charles D., æt. 5 weeks; died March 16th, having had a paroxysmal cough for two weeks, together with syphilitic affection; had been in nursery from birth.	Partial collapse of anterior portion; the remainder of lobe of deep reddish violet colour, — collapse with congestion.	Anterior part healthy; remainder collapsed and congested.	Four-fifths collapsed and deeply congested; a very marked specimen of this combination.	Upper part healthy; anterior tongue collapsed.	Nearly whole of lobe congested and collapsed; some portions not inflated by force used.		State not noted.	Syphilitic affection of skin.

No. of Case.	Name, Age, Account of Illness, etc.	Right Lung.			Left Lung.		Bronchi.	Bronchial Glands.	Other Organs.
		Upper Lobe.	Middle Lobe.	Lower Lobe.	Upper Lobe.	Lower Lobe.			
IX.	Mary W., æt. 9 weeks; died March 17th, after hooping-cough had lasted three weeks; brought up in nursery.	Whitish rose colour; air-cells large.	As upper lobe.	Portions of lower margin collapsed.	In upper half air-cells large; lower half collapsed.	Whole of surface collapsed; collapse does not extend very deeply.	Contain a dirty colored purulent fluid.	State not noted.	
X.	Sarah B., æt. 4 months, died March 22nd, having had for two or three weeks a cough of paroxysmal nature, presumed to be hooping-cough, although no hoop had been heard. Residence in nursery of Workhouse.	Tolerably healthy; air-cells rather too large.	Collapsed in patches.	Lower border affected with collapse.	Healthy.	Large portion of surface collapsed.	Contain but little secretion.	State not noted.	
XI.	Charles P., æt. 1 year; had had hooping-cough two months; diarrhœa for a week before death; died March 22nd.	Small portion collapsed.	Nearly the whole collapsed.	The whole of lower margin and considerable portion of surface collapsed.	Surface pitted, the depressed portions being collapsed; anterior tongue wholly collapsed.	Lower margin and posterior surfacecollapsed.	Contain much rather tenacious mucus.	Large, congested.	Both lungs covered with false membrane, and adherent to ribs. Injection of free borders of valvulæ conniventes of small intestine.
XII.	Eliza L., æt. 2 years; admitted into Infirmary for hooping-cough, Feb. 12th; died March 24th, having become much emaciated; purpura hæmorrhagica and thrush existed for some days before death took place.	Part of the apex healthy; a second portion hepatized, enlarged, hard; section of dull yellow colour, friable. A third portion presents appearances identical in cha-	The lobe is light, and communicates a gurgling sensation on pressure; on the surface are seen large eminences, varying in size from that of a pea to a marble. The	Portion of border collapsed in patches; remainder of lobe presents, on section, small cavities, in character similar to those in the two other lobes.	Anterior tongue composed entirely of vacuoles; no induration of lung substance; walls of vacuoles, thin, constituted externally of pleura and a very thin membrane only.	All the lower part filled with vacuoles of large size; these are well seen on the surface, and, as in the otherlobes, are well defined in outline in this position.	Filled with thick purulent secretion.	A large mass of bronchial glands surround bronchi occupied by cheesy tubercle.	Old adhesions of both lungs to pleuræ; liver almost white. Section under microscope exhibits little else than fat globules. No tubercle in mesenteric glands.

TABLE OF CASES—*continued.*

No. of Case.	Name, Age, Account of Illness, etc.	Right Lung.			Left Lung.		Bronchi.	Bronchial Glands.	Other Organs.
		Upper Lobe.	Middle Lobe.	Lower Lobe.	Upper Lobe.	Lower Lobe.			
		racter with those described in middle lobe.	eminences indicate cavities filled with air, and pus (vacuoles). They communicate freely with bronchi, and are lined by a reddish membrane. The lobe has the appearance of a honeycomb when the pus is washed away.						
XIII.	Henry T., æt. 22 months; had had hooping-cough one month; died March 27th, in nursery of Workhouse.	Air-cells large, giving lobe a puffed-out appearance.	Almost wholly collapsed.	Greater part of lower margin collapsed, also internal surface.	Presents some patches of collapse.	Greater part of lower half collapsed.		Enlarged, congested.	Right cavities of heart filled with blood.
XIV.	Eliza J., æt. 11 months; had hooping-cough three weeks; symptoms became worse ten days before death, when sudden increase of dyspnœa was noticed; died March 29th.	Air-cells large, otherwise healthy.	Collapsed partially; small patches on surface containing muco-pus.	Lower margin collapsed.	At apex, air-cells, large; lower part collapsed; anterior tongue especially affected.	Lobe very small; whole of surface affected with collapse, which condition extends deeply. Section presents small collections of purulent mucus, situated at terminations of bronchia.		Very large, congested.	

No. of Case.	Name, Age, Account of Illness, etc.	Right Lung.			Left Lung.		Bronchi.	Bronchial Glands.	Other Organs.
		Upper Lobe.	Middle Lobe.	Lower Lobe.	Upper Lobe.	Lower Lobe.			
XV.	Susan B., æt. 5 months; ill seven days. Symptoms,—dyspnœa, cough, much thirst, great pallidity; died March 29th.	At the anterior surface are some light red patches of partially collapsed lung; air-cells of remainder of lobe larger than in other lobes.	Collapse of lower and posterior portions, similar in appearance to that in upper lobe; about one-fifth of the lobe involved.	Collapse of lower margin; air-cells adjoining enlarged.	Upper part emphysematous; the tongue-like process wholly collapsed.	Collapse of margin, and also of posterior and inferior surfaces, not, however, extending deeply; a little interlobular emphysema at lower border.	Contain moderate quantity of puriform mucus.	Large and much congested.	Body tolerably covered with fat, vessels of pia mater rather congested; cavity of arachnoid contains half an ounce of serosity; white substance of brain injected.
XVI.	Geo. J., æt. 10 months; died April 2nd, in Salisbury-street; has had hooping-cough severely; last two days convulsions.	Upper portion emphysematous; a small portion of lower border collapsed.	Entirely collapsed.	Lower border collapsed: scattered over the collapsed portion are some vesicles partially aërated.	Anterior portion collapsed; remainder emphysematous.	Lower border collapsed; several sub-pleural ecchymoses.	Contain non-aërated puriform fluid.	Slightly enlarged.	Softening of mucous membrane at cardiac extremity of the stomach.
XVII.	Amy F., æt. 4 years; patient of Dr. Sanderson's at Western Dispensary; died April 17th; had hooping-cough four weeks. Three days before death a sudden change noticed in conformation of chest, which became unduly arched in front. Convulsions two days before death.	Two-thirds of the whole, emphysematous; remainder condensed, firmish, covered with sub-pleural exudation, like that seen under arachnoid. This condensed part assumes characters of upper part on inflation. On section, numerous small cavities, size of small peas are seen; they contain pus.	Condensed, contracted, presents same characters as lower part of upper lobe.	A portion of lower margin collapsed.	Upper part markedly emphysematous; anterior tongue of dark violet colour, resembling in texture the middle lobe, and part of upper lobe of the right lung.	Contains several yellow-coloured granular bodies, which are lobules filled with pus. Lobes adherent together, and to the ribs in part.	Filled with pus, containing little air.	Very much enlarged and congested, not tuberculous.	The lung substance in the portions affected with collapse was harder than in other cases, resembling in some degree cirrhosis of the liver. Inflation did not dissipate this firmness, though restoring the affected portions to their outward natural appearance.

No. of Case.	Name, Age, Account of Illness, etc.	Right Lung.			Left Lung.		Bronchi.	Bronchial Glands.	Other Organs.
		Upper Lobe.	Middle Lobe.	Lower Lobe.	Upper Lobe.	Lower Lobe.			
XVIII.	Catherine H., æt. 4 years; patient in Infirmary; duration of disease somewhat uncertain; died of hooping-cough rather suddenly, April 14th.	All the lobes adherent together, imperfectly crepitant, though not collapsed.	See upper lobe.	See upper lobe.	Emphysematous at apex; no collapse, no tubercle; both lobes adherent behind to ribs.	Lower part occupied by a mass of yellow, white cheesy tubercle, enclosed in a kind of cyst: size of the mass, one inch by half an inch; upper part of lobe presents grey tubercular infiltration.	Contain a little pus.	Filled by tuberculous deposit; one gland projecting into cavity of bronchus on left side.	No tubercle elsewhere; liver pale, nutmeg-colour.
XIX.	Mary A. T., æt. 2 years; patient in Infirmary, admitted with a cough; had hooping-cough for five weeks before death; died April 14th.	Lobe studded superficially and deeply with yellowish grey granulations, very numerous on posterior surface; some patches of violet colour, collapsed.	As upper lobe.	As other lobes; there is a cavity in the centre of this lobe the size of a small nut, containing soft tubercle, arranged in a star-like form.	Anterior tongue collapsed on the surface, and scattered throughout lobe are numerous grey granulations, very hard to the feel.	Lower three-fourths collapsed: contains some granulations of tuberculous nature scattered here and there.		Very greatly enlarged; one on the right side one and a half inch long, filled with cheesy tubercle.	Both pleuræ contain fluid with fibrinous coagula: liver very pale. Peritoneum contains a turbid fluid.

FINIS.

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